# Developing a Method to Rapidly Estimate Fecal-Indicator Bacteria Concentrations in the Cuyahoga River, Cuyahoga Valley National Park, Ohio

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## Introduction and problem

The water quality of the Cuyahoga River within the Cuyahoga Valley National Park (CVNP) is a primary concern to park managers and to visitors of the park. With over 3 million visitors per year, the CVNP is a major destination and recreational resource. The 23-mile reach of the Cuyahoga River within the park receives discharges of storm water, combined-sewer overflows, and incompletely disinfected wastewater from urban areas. These discharges result in a threat to the health of visitors who come into contact with river water during recreational use. Due to the very poor water quality of the river, the park discourages any canoeing, swimming, or wading. Specifically, park managers are concerned about the threat posed to human health from exposure to disease-causing organisms.

Contamination of the Cuyahoga River happens during periods of rainfall and runoff and persists for some time. During those times, public health concerns arise because concentrations of fecal-indicator bacteria are elevated above safe levels. The U.S. Environmental Protection Agency recommends the use of *Escherichia coli* (*E. coli*) and enterococci as fecal bacteria indicators to monitor freshwater recreational waters (U.S. Environmental Protection Agency, 1986). When found in water, these bacteria are useful indicators of fecal contamination from human and animal waste and the possible presence of disease-causing organisms.

Park managers want to promote the use of the river when it is of acceptable quality. Standard plating methods using membrane filtration to monitor the concentrations of fecal-indicator bacteria in the water take 24 hours to obtain results. The elapsed time between the occurrence of elevated fecal-indicator bacteria concentrations in recreational waters and their detection is too long to assess water quality and take adequate control measures in a timely manner. This is especially true in the CVNP where decay, dilution, dispersion, and transport of fecal-indicator bacteria cause concentrations to change greatly over short periods of time. The need for a predictive tool that will provide reliable results of the current day's fecal-indicator bacteria concentrations is widely recognized.

## Goals and objectives

Improvement of water quality and enhanced use of the Cuyahoga River is a long-term goal of the CVNP and its Federal, state, and local partners. Solutions to the problems associated with untreated or poorly treated discharges from combined sewers and wastewater treatment plants will require long-term planning and adequate financing. Long-term solutions to these problems will likely require years to achieve; however, information on the quality of the river is needed now to protect public health. The overall goal of the project is to identify a method that best provides an estimate of concentrations of fecal-indicator bacteria so that park managers can provide daily information to the public on the safety of the river for recreational use.

To achieve this goal, specific objectives of the proposed study are to:

1. test the IMS/ATP rapid method for *E. coli* and enterococci and determine how well its results correlate with results obtained using standard plating methods,
2. investigate the use of readily-measured variables, including streamflow, rainfall, turbidity, and the IMS/ATP rapid method results, as a predictive tool for *E. coli* or enterococci concentrations, and
3. test and compare the efficacy of the methods for estimating fecal-indicator bacteria concentrations.

**Approach**

One approach to rapidly estimate fecal-indicator bacteria concentrations is to use an analytical method for *E. coli* or enterococci that provides results within 1 hour. In this study, we will test an immunomagnetic separation (IMS)/adenosine triphosphate (ATP) rapid method. Bacteria are first concentrated from the water sample by serial filtration. Magnetic beads that are coated with antibodies for either *E. coli* or enterococci are added to the concentrate. This mixture is then subjected to IMS, in which the bacteria-antibody bead complex is separated from extraneous materials by use of a magnet. Following IMS, the bacterial cells are ruptured and ATP, which is the energy molecule found in living cells, is released and measured with a microluminometer. Results are recorded as relative light units (RLU). In previous studies done at the University of Michigan, results from the IMS/ATP rapid method showed a strong correlation between RLUs and the standard plating method for *E. coli* (Lee and others, 2002).

Both *E. coli* and enterococci will be examined using the IMS/ATP rapid method in the initial phase of this study. The reason for analyzing both is that the antibodies for *E. coli* target a large and diverse group of enteric organisms that include *E. coli* but may include other bacteria, whereas the antibodies for enterococci specifically target the fecal streptococcus group, of which entercocci is a major subgroup. Following the first phase of the study, the method that better correlates to the standard plating method will be selected and then used to collect daily samples during the second phase of the study.

Another approach to rapidly estimate fecal-indicator bacteria concentrations is to develop a predictive tool using water-quality and environmental variables as surrogates for concentrations of fecal-indicator bacteria. Possible surrogates that will be tested during this study include IMS/ATP rapid method results and streamflow, rainfall, and turbidity, which are measured quickly or are available as real-time data.

The information derived from this study will assist park managers in their efforts to promote utilization of the river and at the same time protect the health and safety of park visitors. Park managers can use this information to provide accurate, timely assessments of recreational water quality that they can communicate quickly to the public, for example, by way of the Internet or in-park postings.